HÜTTMEIER / WAYSS & FREYTAG JV

Noise Contour Study
293rd BSB Mannheim, Germany

REPORT

(FINAL)

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Prepared for:

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1 Summary

The noise effects on the neighborhood of four installations in the area of 293rd BSB Mannheim were investigated. These are Benjamin Franklin Village (commercial noise), Coleman Barracks (aircraft noise), Lampertheim Local Training Area (firing noise) and Spinelli Barracks (commercial noise). In Turley Barracks, insufficient noise sources were available for measurements during the field work period. This site was therefore removed from the investigation program.

The noise effects of the installations mentioned were determined in part by measurements and in part mathematically, represented in numerous noise contour maps and assessed on the basis of current German regulations. In some cases violations of the permissible limit or imission guide values according to German regulations are expected. The impacts were described and noise abatement measures proposed in principle.

The following core statements can be made in summary.

In BFV, no violation of the immission guide values is expected during daytime; at night however, and particularly east of the PX, substantial violations due to the operation of the cooling units are expected. Extensive and coordinated noise remediation will be necessary here.

During the investigation of Coleman Barracks it was shown that maximum level transgressions only occur immediately adjacent to the runway, not, however, in residential areas. Therefore, no nuisance is expected here.

Lampertheim LTA adheres to the imission guide value for general residential areas during daytime. There are three areas where the immission guide values are exceeded at night, in part substantially: "An der Wildbahn", Neuschloß and parts of Hüttenfeld. The installation of baffles and a reduction of rounds fired at night were proposed as noise abatement measures.

In contrast, no violations of the the immission guide values are expected in the area of Spinelli Barracks. At the current time no noise abatement measures are deemed necessary.

2 Introduction

Hüttmeier/Wayss & Freytag JV was commissioned by the US Army to conduct a noise contour study at five different sites of the 293rd BSB Mannheim, Germany. The locations of these investigations are (in alphabetical order)

- Benjamin Franklin Village (BFV)
- Coleman Barracks
- Lampertheim Local Training Area (LTA)
- Spinelli Barracks

In Turley Barracks, insufficient noise sources were available for measurements during the field work period. This site was therefore removed from the investigation program.

The contractually agreed upon services are described in detail in the revised Schedule of Services (SOS) dated 23rd September 2000 and in the Work Plan of February 14, 2003

The aim of the current investigation is:

- to record all relevant noise sources at the above mentioned installations,
- to calculate ambient noise exposure and to represent this in noise contour maps,
- to assess noise exposure in the neighborhood according to current German regulations and,
- where necessary, to make proposals for noise abatement measures available in principle.

3 Abbreviations

AzB	Instructions for the Calculation of Noise Protection Areas (Aircraft noise) *(Anleitung zur Berechnung von Lärmschutzbereichen (Fluglärm)*
BFV	Benjamin Franklin Village
DIN	(German Standardization Institute) *Deutsches Institut für Normung*
DAS	Data acquisition system
IFR	Instrument Flight Rule
LTA	Local Training Area
MTOM	Maximum Take Off Mass
POC	Point of contact
SOS	Schedule of services
TA Lärm	Technical Instructions on Noise Protection *(Technische Anleitung zum Schutz gegen Lärm)*
VDI	Association of German Engineers *(Verein Deutscher Ingenieure)*
VFR	Visual Flight Rule

4 Reference materials

4.1 *Index of reference materials*

[1] Digital site maps, 2003

[2] Digital raster map data: Topographic map 1:50.000, Landesvermessungsamt Baden-Württemberg, 2003

[3] German Technical Noise Directive "Sixth General Administrative Regulation to the Federal Imission Control Bill (Technical Instructions on Noise Protection - TA Lärm), August 26, 1998"

[4] Instructions for the Calculation of Noise Protection Areas at Civilian and Military Airfields According to the Aircraft Noise Protection Bill of March 30, 1971 (Federal Law Gazette I p. 282) - AzB of 02/27/1975 (Joint Ministerial Gazette No.8 p.162)

[5] Instructions for the Calculation of Noise Protection Areas at Civilian and Military Airfields according to the Aircraft Noise Protection Bill of March 30, 1971 (Federal Law Gazette I p. 282) – Instructions for Calculation (AzB) of 02/27/1975 (Joint Ministerial Gazette No.8 p.162) and the Supplement to the Instructions for the Calculation of Noise Protection Areas at Civilian and Military Airfields – AzB – of 02/27/1975 (Joint Ministerial Gazette No.8 p.163) of 02/20/1984, The Federal Minister for Home Affairs, V II 4 – 560 120 / 43

[6] AzB Draft by the Federal Environment Agency with aircraft groups, 1999

[7] ISO 9613-2: 1996 (Draft) "Attenuation of Sound During Propagation Outdoors - Part 2: General Method of Calculation", September 1997

[8] DIN 45643-3, Measurement and Assessment of Aircraft Noise; Determination of Rating Level of Aircraft Noise Exposure, October 1984

[9] DIN 45682 (Draft) "Sound imission maps", June 1997

[10] VDI 2571 "Sound Radiation from Industrial Buildings", August 1976

[11] VDI 2714 "Outdoor Sound Propagation", January 1988

[12] VDI 2719 "Sound Isolation of Windows and their Auxiliary Equipment", August 1987

[13] VDI 2720 Sheet 1 "Noise Control by Barriers Outdoors", March 1997

[14] VDI 3745 Sheet 1 "Assessment of Shooting Noise", May 1993

[15] Griefahn, Jansen, Scheuch, Spreng; Erarbeitung von Fluglärmkriterien für ein Schutzkonzept bei wesentlichen Änderungen und Neuplanung von Flughäfen/Flugplätzen, February 2002 *(Compilation of Aircraft Noise Criteria for a Protective Model at Newly Planned Airports/Airfields or Those Subject to Substantial Alterations)*

[16] Cadna/A Version 3.2.101, Computer application for noise exposures predictions, Datakustik GmbH, Munich

4.2 *Evaluation of existing noise studies*

Previous noise studies either do not exist or are not available, or are unknown to the contractor.

4.3 *Aircraft Noise*

The following standards, directives and rating sources are utilized to calculate and assess the aircraft noise situation around the airfield:

- DIN 45643-3 (Measurement and Assessment of Aircraft Noise) [8]
- Instructions for the Calculation of Noise Protection Areas at Civilian and Military Airfields (AzB) [5]
- Aircraft groups and emission spectra according to AzB 99 (Draft) and AzB 84 [6]
- Noise-related health criteria *(Lärmmedizinische Kriterien)* (Scheuch) [15]

4.3.1 Terms and definitions

A number of terms and definitions from the field of acoustics are explained here; they are used in this chapter with reference to aircraft noise but generally also apply to the other types of noise investigated.

Sound pressure level

The sound pressure level in dB (decibels) is a logarithmic unit for the power of a noise at a given place and a given time. Generally - including for the assessment of aircraft noise - the A-weighted sound pressure level in dB(A) is used. The A-weighting takes into account the varying sensitivity of human hearing to a range of frequencies. Due to this approximate physiological correction it can be assumed that noises with the same sound pressure levels in dB(A) are regarded as roughly equally loud, independent of the "noise character" or, more correctly, the frequency spectrum. All levels are therefore given in dB(A).

Maximum level

If noises with a temporally variable level act on an imission point for a given period of time, the highest recorded sound pressure level in dB(A) is known as the maximum level. Where aircraft noise is concerned, a rising and then falling sound pressure level results for any given location for each fly past or flyover. The highest individual aircraft noise sound pressure level event – relating to the SLOW time rating – is the maximum level. All aircraft noise events taken together generate a maximum level distribution.

Time-averaged sound pressure level or energy-equivalent continuous sound pressure level

A time-averaged sound pressure level describes any fluctuating noise effects, with regard to the noise level, during a given period of time. With regard to the mean volume and nuisance effects, it is assumed that a noise at a given level and a given duration is regarded as a noise with a 3 dB higher sound pressure level and only half the duration when calculating this time-averaged sound pressure level or energy-equivalent continuous

sound pressure level Leq. This corresponds to the energy transport of a sound wave – for a 3 dB higher sound pressure level and duration reduced by half at a section crossed by the sound wave, the sound energy transported remains the same. This is why this time-averaged sound pressure level with an equivalence parameter q = 3 is also known as the energy-equivalent continuous sound pressure level.

In the whole field of imission control - with the exception of those areas regulated by aircraft noise legislation - this energy-equivalent continuous sound pressure level is used to arrive at a mean characteristic value for day or night values, or for other defined periods of time. The equivalence parameter q = 3 is also used as the basis for this aircraft noise investigation [8].

Rating level

The rating level caused by airfield operations is used to characterize the noise effects during the day or night reference period. This is the time-averaged sound pressure level acquired using the equivalence parameter q = 3 dB during the reference period. The reference period for daytime is from 0600 until 2200 and from 2200 until 0600 for nighttime.

4.3.2 Assessment

The specification of requirements - which a rating must adhere to - should always be oriented to the effect aspects. However, this is generally difficult because research into the effects is currently uncertain as to the differentiation required to facilitate practical implementation. It is therefore expedient to include both the requirements mentioned in proven regulatory works - which are often based on empirical values – and more recent statements on the psychology and medicine of noise.

For an adequate evaluation, current expert opinions on noise medicine [15] demand and justify the following time-averaged sound pressure levels and maximum levels in the surroundings of an airfield:

day:
time-averaged sound pressure level: 55 dB(A), 60 dB(A), 65 dB(A),
Frequency of a maximum level of 90 dB ≥ 25x

night:
time-averaged sound pressure level: 45 dB(A), 50 dB(A), 55 dB(A),
Frequency of a maximum level of 75 dB ≥ 6x

4.4 *Industrial Noise*

Noise abatement concerns for industrial and plant noise are regulated in the *TA Lärm* **[3]**. This serves to protect the general public and the neighborhood from adverse environmental effects by noise as well as the prevention of such adverse environmental effects. From the point of view of the neighborhood of the installations influenced by noise, they can be treated as installations in accordance with *TA Lärm*. The permissible imission guide values for imission points outside of buildings are:

a) In industrial estates 70 dB(A)

b) in commercial zones
daytime 65 dB(A) and
night 50 dB(A)

c) in core areas, village areas and mixed areas
daytime 60 dB(A) and
night 45 dB(A)

d) in general residential areas and small residential estate areas
daytime 55 dB(A) and
night 40 dB(A)

e) in pure residential areas
daytime 50 dB(A) and
night 35 dB(A)

f) in spa areas, for hospitals and care facilities
daytime 45 dB(A) and
night 35 dB(A)

Furthermore, the *TA Lärm* contains much more precise regulations for the assessment of individual noise peaks and low frequency noises, which are, however, just as meaningless in this case as awarding surcharges for times of day with increased protection requirements (0600 - 0700 and 2000 - 2200).

According to *TA Lärm*, the noise effects can be determined either by measurements or by means of mathematical prediction. In the present case the noise emissions of the individual noise sources are measured and the effects on the neighborhood of these noise sources determined mathematically.

4.5 *Firing Noise*

Noise abatement issues for firing ranges are regulated in VDI 3745 Sheet 1 [14]. This directive describes procedures for measuring and assessing firing noise from small

firearms in the neighborhood of firing ranges. Noise emissions from firing ranges are impulse sound events, which occur irregularly and often with large level differentials to the existing background level. They are therefore generally of a different nature to the industrial noise mentioned above and to ambient noise.

For the assessment of firing noise, VDI 3745 refers to the imission guide values in VDI 2058, Sheet 1, "Assessment of working noise for neighboring areas", which has, however, now been withdrawn. Instead, the imission guide values - of identical magnitude - given in *TA Lärm* are used (see Section 3.4).

VDI 3745 precisely defines the procedure for measuring firing noise and defines, amongst other things, the number of measurement values required, the extent of random sampling and the permissible range of values. The measured variable used to describe the firing noise imissions is the A-weighted, maximum sound pressure level L_{AFmax} of each single shot, determined using the FAST time rating.

Various characteristic time periods (working days or Sundays, day or night) are separately evaluated and used for forecasts in accordance with VDI 3745. Furthermore, weighting factors are defined for times of day in which the nuisance effect may be increased (mornings, evenings, Sundays), as well an impulse noise surcharge in due consideration of the characteristic properties of firing noise.

The magnitude of firing noise emissions is primarily dependent on the type of weapon, the caliber and the ammunition used. Because in this case it was not possible for organizational reasons to measure every weapon that can theoretically be used at the investigated firing range, the client decided to test only the weapon which is used by far the most often, the M-16.

4.6 *Procedure*

Prior to the interviews a questionnaire with required data, documents and information was sent to the nominated POC of each site. The investigation sites were visited and the points of contact were interviewed on 28th and 29th October and 6th and 7th November, 2002. Some documentation was handed over during these meetings. It was decided to hand over further material later.

Any missing data was collected at the subsequent measurement appointments (e.g. geometry of buildings and noise sources, missing documentation and drawings, descriptions of facilities by the personnel present), as well as carrying out the measurement itself.

4.7 *Models and programs*

The visits to the investigation sites indicated that consideration of a ground floor model is not necessary. The topographic situation can be considered as straightforward for acoustic purposes.

All relevant screening and reflecting objects (buildings, walls, etc) inside the investigation sites, as well as in the surrounding areas, will be included in an electronic 3-dimensional model. This is based on the digital plans provided, which, however, only comprise the installations or, in individual cases, the direct neighborhood. In individual cases relevant buildings not contained in the digital plans were manually modeled (based on the topographic map) for noise propagation or assessment. The building height will be estimated as far as possible by the number of floors or by the footprint of the building. Building heights that are relevant for reflection or screening were measured more precisely during the site visits (noise monitoring).

In regions for which no digital data (of buildings) is available, calculations are based on free sound propagation. At these spots in the subsequent noise contour map representation, the topographic map is underlain in order to make built-up areas optically recognizable.

All relevant noise sources will be included in the model. Their noise emission parameters are taken from the measurement results (where available) or from regulations, the literature or empirical values.

The model will be developed and the calculations carried out using the Cadna/A Version 3.2 software (Datakustik GmbH, Munich). Cadna/A is a software program for the prediction and assessment of noise levels in the vicinity of industrial facilities, traffic-systems such as roads, rail- or waterways, airports and landing fields and any other noise-relevant facilities. The program features easy input and configuration of terrain including all objects that influence noise emission and propagation, the calculation and documentation of noise levels in accordance with national regulations, and presentation of the results with noise contour plots and colored noise maps (see www.datakustik.de).

3.2 Modeling output

Noise contour maps will be calculated and printed out:

- separately for each of the four investigation sites,
- separately for each noise type (aircraft noise, firing noise, industrial noise) and
- separately for day and night (provided that noise occurs at night).

In contrast to the SOS of 23rd September 2002, a day-night average noise level will not be calculated. The German FGS regulates a separate calculation for day and night but does not demand day-night average noise levels.

The calculations will be carried out for a 10 m x 10 m grid or a similar grid depending on the local conditions. The size of the calculated area depends on the height of the expected noise levels and the distance to the adjacent housing areas. It will be defined later. The

noise level is calculated at each intersection of the grid (e.g. an investigation area of 1 km² with a 10 m x 10 m grid contains 10,000 calculation points). The noise level within the calculation area will be displayed in 5 dB(A) intervals as colored iso-dB lines (lines of constant noise level) (aircraft and firing noise) or as colored areas of constant noise level (industrial noise).

The size of the maps depends on the distance between the investigation site and the adjacent housing areas and the magnitude of the noise effects in the neighborhood. A proper scale for the hardcopies will be defined at a later point in time depending on the results.

The assessment of the noise in the neighborhood of the investigation locations will be performed qualitatively based on the noise contour maps. The assessment will follow the German regulations mentioned above. Areas or single buildings where the admissible noise levels are exceeded will be listed separately for each noise type and for day and night.

4.8 *Quality control*

The quality of the measured noise levels is guaranteed, as all measurements are carried out pursuant to German regulations and FGS. If it is necessary to deviate from these regulations, a detailed explanation why different procedures were chosen will be provided. Furthermore, an estimation of the expected variation of measured noise levels due to this procedure will be given.

Further quality control is guaranteed, as all measurement equipment employed is regularly calibrated by an office of the German Bureau of Standards and checked by the measuring personnel prior to commencing work.

The contractor (ACCON) is an officially authorized measuring consultant pursuant to German regulations (Certified body for measurements in accordance with Para. 26 Federal Imission Control Bill) and conforms to all quality specifications for noise monitoring.

With regard to the calculation quality of the “Cadna/A” computer application, the developer, DataKustik states: "Cadna/A is based on standards, guidelines and other technical papers. DataKustik cannot guarantee for the correctness or even for a certain accuracy of the models behind these. But a set of about 100 test problems with well known exact results is recalculated in Batch-mode after each step in program development. Development is only continued if deviations are within defined tolerances (< 0.1 dB)" (see www.datakustik.de)

4.9 *Presentation of results*

The results will be summarized in this report. This report will include the measurement results, details of the calculation model, in particular the noise emission parameters adopted, the noise rating for the neighborhood and the noise contour maps.

The report quality is guaranteed because it is written by an acoustic expert and reviewed by a native English speaker.

This report is also available to the client on CD-ROM.

The results of the noise contour study will be presented at the final meeting.

5 Benjamin Franklin Village (BFV)

BFV is situated North of the B 38 in Mannheim-Vogelstang. However, relevant sound sources are only to be found in the Southeast of BFV, West of Waldeckweg. The PX and Food mall buildings are located here. The following sound sources were taken into consideration for this report:

- diverse ventilation and cooling units on the roof and facade of the Food mall,
- 7 large cooling units at the rear of the PX,
- loading yard at the rear of the PX (truck noises, loading noises).

The sound power of the units at the PX and the Food mall were determined by measurements on 06/04/2003, the truck and loading noises were determined mathematically.

The nearest residential area is further to the East, beyond Waldeckweg. These are multi-story residential and business buildings. Residential areas can be found at greater distances to the North and South and are separated by traffic routes with heavy traffic passage (Birkenauer Strasse, B 38).

5.1 *Food mall ventilation and cooling units*

A total of 13 sound sources were discovered on the roof and the Northwest facade of the Food mall; these are shown in. The measurements resulted in the sound power levels listed in Table 1, whereby three units were not operating at the time the measurements were taken.

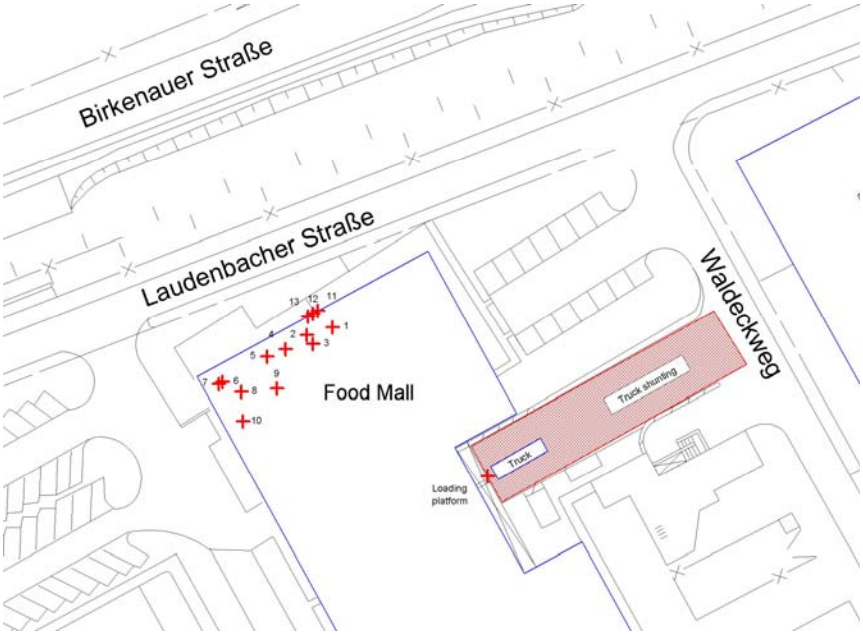

Figure 1: Sound sources at the Food mall and the loading zone

Sound source designation	Sound power L_{WA}	Coordinates		
	Value	X	Y	Z
	(dB(A))	(m)	(m)	(m)
1	85	3466754.69	5486955.23	7.30
2	OFF	3466750.39	5486953.89	7.30
3	90	3466751.42	5486952.43	7.30
4	73	3466746.81	5486951.53	7.30
5	70	3466743.76	5486950.28	7.30
6	OFF	3466736.35	5486946.06	7.30
7	86	3466735.75	5486945.76	7.30
8	86	3466739.45	5486944.42	7.30
9	74	3466745.39	5486944.98	7.30
10	OFF	3466739.71	5486939.51	7.30
11	69	3466752.23	5486958.00	2.00
12	72	3466751.36	5486957.52	3.50
13	69	3466750.56	5486957.08	2.00

Table 1: Sound power level, Food mall units

For calculation purposes uniform, 24-hour operating is assumed for the above sound power levels.

5.2 *Food mall / PX loading zone*

According to the operators, loading activities only take place at the location marked in, Figure No. 1, loading activities take place at night.

Two sound sources were adopted for modeling: maneuvering of trucks in front of the loading ramp (area source) and driving over the truck tailgate by the platform floor truck and forklift (point source).

The critical source when maneuvering is the truck engine noise (increased idle). For trucks, a sound power level of 99 dB(A) is adopted relative to 1 hour of maneuvering. It is assumed that one truck is loaded/unloaded every hour (including supply and disposal vehicles), i.e. a total of 16 trucks per day. A sound power level correction of 0 dB is adopted. An average duration of 5 minutes per hour is adopted for maneuvering. This gives a correction of -11 dB. The area source is therefore adopted with a sound power level of 88 dB(A).

The critical source during loading and unloading of trucks is the impulse noise generated when driving over the tailgate with a platform floor truck or forklift. For this noise, a sound power level of 88 dB(A) is adopted relative to 1 sound event. It is assumed that each truck transports an average of 20 palettes, so that 40 sound events result; i.e. a total of 640 sound events per day with a total of 16 trucks. A sound power level correction of +28 dB is adopted. The noises are distributed during a daytime period of 16 hours; this

results in a time correction of -12 dB. The point source is therefore adopted with a sound power level of 104 dB(A).

These relatively high assumptions (16 trucks per day) also contain the noises caused by occasional journeys of supply and disposal vehicles (e.g. garbage disposal).

The self-screening of loading noises by the trucks with regard to the eastern residential area is taken into consideration in the model.

5.3 *PX cooling units*

Seven large cooling units are located at the rear of the PX at Waldeckweg. They are marked in Figure No. 2.

Figure 2: PX sound sources

The measurements provide the sound power levels listed in Table 2, whereby at the time of measurement both fans were operating on some units, on others the fans were not operating and some of the units were not operating at all.

Designation	Fans running	L_{WA} (dBA)
1	right	87
2	both	92
3	OFF	-
4	both	91
5	left	92
6	left	92
7	OFF	-

Table 2: Sound power levels PX units

According to the operators, the units operate automatically 24 hours a day. However, because the units were in varying operating conditions at the time the measurements were taken, an average sound power level generated from the 7 values measured will be adopted for each unit and used for further calculations. The average sound power level is 90 dB(A).

5.4 *Assessment*

Noise contour maps were calculated on the basis of the above-mentioned measurements and assumptions; they can be found in Annex A1 and A2 . The calculation height was 6 m above the ground and the calculation points were on a 5 m x 5 m grid.

5.4.1 Day

The noise contour map shows no that no sound sources in excess of the imission guide values are expected to the North and South of the PX and Food mall due to the distance between the sources and the imission points. The levels on the far side of Birkenauer Strasse and the B 38 demonstrate a maximum of 50 dB(A) and fall below the permissible imission guide values for general residential areas by at least 5 dB(A). Furthermore, it can be assumed for this area that the noise generated by the road traffic is substantially higher in comparison.

East of the PX and the Food mall, at the nearest residential area on Waldeckweg, levels of up to 59 dB(A) are reached. This falls short of the imission guide value for mixed zones by at least 1 dB(A). An assessment as mixed zone appears reasonable here considering that the houses include both residential and business properties. Nevertheless, the imission guide values for both mixed zones and for general residential areas are adhered to at the rear of these buildings as well as at the residential buildings further to the East.

5.4.2 Night

The noise contour map shows that sound sources in excess of the imission guide values are expected to the North of the PX and Food mall despite the distance between the sources and the imission points. The levels on the far side of Birkenauer Strasse demonstrate a maximum of 49 dB(A) and exceed the permissible imission guide values for general residential areas by at least 9 dB(A). If the area in question is classified as a mixed zone, the excess is still 4 dB(A).

In addition, the imission guide values are exceeded to the South of the PX and the Food mall, despite the great distance between the sources and the imission points. The levels on the far side of Birkenauer Strasse demonstrate a maximum of 43 dB(A) and exceed the permissible imission guide values for general residential areas by at least 3 dB(A). If these areas are classified as mixed zones, the imission guide value is fallen short of by

2 dB(A). Furthermore, it can be assumed for these areas that the noise generated by the B 38 traffic is substantially higher in comparison.

East of the PX and the Food mall, at the nearest residential area on Waldeckweg, levels of up to 57 dB(A) are reached. The imission guide value for mixed zones is thus exceeded by at least 12 dB(A). An assessment as mixed zone appears reasonable here considering that the houses include both residential and business properties. Nevertheless, the imission guide values for mixed zones are generally adhered to at the rear of these buildings as well as at the residential buildings further to the East.

A substantial potential for conflict may develop here, considering that not even the imission guide value for industrial areas can be adhered to along Waldeckweg. An undisturbed night is only possible here with closed windows. Even if it assumed that the noises emanating from the B 38 are of a similar magnitude, industrial noise must still be taken into consideration as a separate entity, according to current regulations.

5.5 *Noise abatement measures*

In order to improve the noise situation for those concerned the following noise abatement measures may be considered in principle:

- screening or complete enclosure of the PX cooling units,
- screening, silencers, enclosure of the units at the Food mall,
- optimization of the individual unit controls with the aim of reducing the night running time to a fraction of the present value.

Simple improvements will lead to adherence to the imission guide values for the population to the South and North of the PX and the Food mall. However, for those primarily impacted on Waldeckweg, extensive and coordinated noise remediation will be necessary.

6 Coleman Barracks

The military airfield at Coleman Barracks lies to the North of Mannheim, 3 km East of the Rhine. The take-off and landing strip is aligned at 50°/230°. The surroundings of the airfield are represented in the isophonic maps in the Annex.

6.1 *Analysis model*

The noise situation in the neighborhood of Coleman Barracks military airfield is assessed taking air operations only into due consideration. The ground sources connected to airfield operations are not the subject of this investigation.

The basis for calculations is provided by:

- DAS (*data acquisition system*) which describes the future flight operations at Coleman
- copy of geometry of flight routes
- copy of master plan
- VFR / IFR description

Calculation of aircraft noise is carried out according to the procedures described in the Instructions for the Calculation of Noise Protection Areas at Civilian and Military Airfields according to the Aircraft Noise Protection Bill, AzB [4], but adopting an equivalence parameter q = 3. The aircraft group divisions used in AzB 99 [6] are utilized for mathematical determination of aircraft noise imissions.

The aircraft groups adopted are defined as follows:

P MIL1	Propeller aircraft with MTOM to 5.7 t
P MIL2	Propeller aircraft with MTOM above 5.7 t
S 5.1	Jet aircraft with MTOM to 50 t
H 2:	Helicopters with MTOM above 2.5 t

Table 3: Aircraft groups

Aircraft movements and their distribution along flight routes, and the aircraft groups, were provided in the shape of a DES-MIL (*data acquisition system*) by the airfield operator. The noise investigation is based on the following distribution of flight movements to aircraft groups:

Aircraft group	No. of departures		No. of arrivals	
	Day	Night	Day	Night
P MIL1	1930.00	56.00	757.00	82.00
P MIL2	48.00	0.00	48.00	0.00
H 2	1903.00	95.00	893.00	105.00
S 5.1	192.00	6.00	142.00	40.00
Total	4073.00	157.00	1840.00	227.00

Table 4: Flight movements in the 6 months with heaviest traffic

The AzB 99 (Draft) classes were adopted for the aircraft groups H 2 and S 5.1; the AzB 75 classes were adopted for the P-MIL1 and P-MIL2.

6.2 *Assessment*

Flight noise assessment is based on the emissions on an average day during the 6 months with heaviest traffic. Noise contour maps were calculated on the basis of the above-mentioned assumptions; they can be found in Annex B1 and B2. The calculation height was 6 m above the ground and the calculation points were on a 50 m x 50 m grid.

6.2.1 Day

The rating levels caused by aircraft operations are calculated, taking current noise-related health requirements into consideration [15], and subsequently graphically represented (noise contour map, Annex B1), beginning at 55 dB(A) and progressing in 5 dB steps. In addition, maximal level transgressions of 25 x 90 dB(A) are used as preventative guide values and critical tolerance values.

55 dB(A) were exceeded in the following areas (from East to West):
- in the South of Lampertheim (a few buildings on the edge of town)
- in the North of Mannheim-Blumenau (a few buildings on the edge of town)
- Coleman Barracks
- Mannheim-Scharhof
- in the North of Mannheim-Sandhofen (edge of town)
- Frankenthal-Petersau
- Beindersheim

60 dB(A) were exceeded in the following areas (from East to West):
- parts of Coleman Barracks
- in the South of Mannheim-Scharhof
- parts of Frankenthal-Petersau (a few buildings)

65 dB(A) were exceeded in the following areas (from East to West):
- parts of Coleman Barracks (a few buildings near the runway)
- in the South of Mannheim-Scharhof (a few buildings on the edge of town)

From an imission control point of view, sound insulation measures (e.g. sound insulating windows) should guarantee that all living rooms and bedrooms in the residential buildings within the 60 dB(A) contour do not exceed an interior level (16-hour equivalent continuous sound pressure level) of 40 dB(A).

It was shown that maximum level transgressions of 25 x 90 dB(A) only occur immediately adjacent to the runway, not, however, in residential areas. Therefore, no nuisance is expected here. Representation in a map is dispensed with.

6.2.2 Night

For nighttime assessment criteria apply which consider the adverse impacts on health of disturbed sleep [15]. The corresponding isophonic lines at 45 dB(A), 50 dB(A) and 55 dB(A) are represented in the noise contour map in Annex B2. In addition, maximum level transgressions of 6 x 75 dB(A) are used as preventative guide values and critical tolerance values.

45 dB(A) were exceeded in the following areas (from East to West):
- in the South of Lampertheim (a few buildings on the edge of town)
- Coleman Barracks
- Mannheim-Scharhof
- in the North of Mannheim-Sandhofen (edge of town)
- Frankenthal-Petersau
- Beindersheim
- Heßheim

50 dB(A) were exceeded in the following areas (from East to West):
- parts of Coleman Barracks
- in the South of Mannheim-Scharhof
- Beindersheim

55 dB(A) were exceeded in the following areas (from East to West):
- parts of Coleman Barracks (a few buildings near the runway)

From an imission control point of view, sound insulation measures (e.g. sound insulating windows) should guarantee that all bedrooms and children's bedrooms in residential buildings within the 50 dB(A) contour do not exceed an "interior level" (8-hour equivalent continuous sound pressure level) of 35 dB(A).

Due to the low number of flight movements during the night, no maximum level transgressions of 6 x 75 dB(A) occur. Therefore, no nuisance is expected here. Representation in a map is dispensed with.

6.3 *Noise abatement measures*

The effects of the planned flight operations were calculated and assessed. If the projected flight operations come about, the existing sound insulation on residential buildings and other sensitive buildings (e.g. retirement homes) must be examined. If necessary, further noise abatement measures must be taken. Noise abatement measures may be necessary on existing windows, doors, roller shutter housings and further exterior building components (e.g. roof). Sound absorbing ventilators must be fitted in bedrooms to protect from nighttime aircraft noise and simultaneously guarantee sufficient fresh air supply with the windows closed.

7 Lampertheim Local Training Area (LTA)

Lampertheim LTA is situated in a large forested area North of Mannheim between the A 67 to the East, the A 6 to the South, Lampertheim to the West and the Lampertheim-Hüttenfeld road (L 3110) to the North. The investigated TCT range, a 25 m range, is located halfway between Neuschloß and Hüttenfeld around 700 m (~ 765.5 yards) South of the L 3110. The range was once used as a 300 m range; the installation is therefore surrounded by extensive embankment systems, crowned to a great extent with walls.

Residential areas requiring protection can be found in Neuschloß (about 2 km Northwest of the range), Hüttenfeld (about 2.5 km to the East) and a farm, "An der Wildbahn" (about 1.5 km East).

7.1 *Measurements*

The range was surveyed on 05/07 and 05/08/2003 in order to compile the analysis model, the measurement points were defined and the noise measurements subsequently carried out at the TCT range. The results are described here. The TCT range analysis model with the measurement points and sound sources is represented in Figure No. 3.

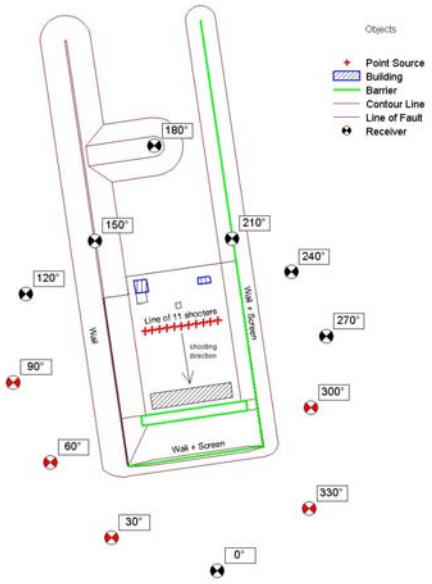

Figure 3: Analysis model and location of measurement points at the TCT range

The measurements were taken conforming to the guidelines in VDI 3745 [14].

For this purpose, measurement points are defined around the range, at a distance of 40 m to 100 m in 30° steps with reference to the direction of fire (0°). Equidistant measurements were not possible because the locations of the measurement points had to be adjusted to local conditions (forest tracks, embankments and walls, partly inaccessible

land and undergrowth). Lesser distances were not possible for safety reasons. The locations of the measurement points are represented in Figure 3: Analysis model and location of measurement points at the TCT range.

Only M-16 assault rifles were fired (single shot). Up to 11 firers were on the range simultaneously. Because the running practices could not be disturbed it was not possible to take measurements of individual shots of a single firer. Nevertheless, it was possible to acquire individual shot events capable of being evaluated due to the fact that some (slower) firers took longer than others and thus were still issuing single shots towards the end of each practice.

The minimum number of required measurements for each microphone position is taken from VDI 3745 as a function of the range of measurement results. The A-weighted maximum level is measured with the time constant FAST L_{AFmax}. The mean single shot level L_m is then acquired from the energy mean of the individual measured values. Table 5: TCT range measurement results summarizes the measurement results.

Measurement point	Smallest value	Largest value	Range	Required sample size	No. of values	Mean single shot level
	$\min(L_{Afmax,i})$	$\max(L_{Afmax,i})$	R	n	n	L_m
	dB(A)	dB(A)	dB			dB(A)
0°	73.2	75.6	2.4	10	21	74.3
30°	75.4	83.3	7.9	10	15	80.4
60°	81.0	86.2	5.2	10	23	83.7
90°	80.0	82.9	2.9	10	13	80.6
120°	78.8	81.4	2.6	10	17	80.1
150°	98.5	102.8	4.3	10	28	101.3
180°	98.3	101.9	3.6	10	20	100.3
210°	102.0	105.9	3.9	10	18	103.8
240°	78.5	84.9	6.4	10	16	81.0
270°	79.4	84.6	5.2	10	17	81.1
300°	80.0	84.6	4.6	10	23	81.8
330°	74.5	78.9	4.4	10	10	76.6

Table 5: TCT range measurement results

During the measurement campaign, noises from a generator and a fan unit for extracting fumes from the butts were investigated. It was shown that these noises were only of subordinate importance compared to the firing noises and therefore need not be considered further.

7.2 *Analysis model*

By means of the single shot levels determined from measurements a model can now be back-projected to arrive at the sound power of a mean single shot of a point source, and its directional response.

This results in a sound power level for the "M-16" point source of 140 dB(A) for a single shot and direction as given in Table 6.

Direction	Correction
	dB
0°	7.0
30°	8.5
60°	10.0
90°	4.0
120°	2.0
150°	2.0
180°	2.0
210°	2.0
240°	2.0
270°	4.0
300°	10.0
330°	8.5

Table 6: Directional response

It is shown that the weapons measured demonstrate a maximum at ±60° and are 10 dB quieter to the rear (180°) than in the firing direction (0°). This result correlates well with the expectations from other measurements and with literature examples.

Surcharges and reductions are now adopted for the sound power level representing the maximum level of a single shot, for

- the range operating times,
- the increased nuisance of firing noise during rest periods (weighting factor 4 for noises during these periods),
- the total number of shots fired during the assessment period and
- the increased nuisance due to impulse noise (impulse noise surcharge Z_I = 16 dB),

calculated in accordance with VDI 3745. The operating times and shot counts as provided by Range Control are summarized in Table 7.This leads to a daytime and a night surcharge of 6 dB and 5 dB respectively, which is added to the sound power in the model.

Characteristic time	No. of shots	Remark
Working day, daytime 0600 - 0700 (Rest period)	-	No operations
0700-1900	40,000	
1900 - 2200 (Rest period)	2,400	"Night fire" (one hour after sunset)
Working day, night (most unfavorable hour at night between 2200 - 0600) here: 2200-2300	2,400	Night fire in Summer (one hour after sunset)
Sunday, public holiday	-	No operations

Table 7 Operating times and shot counts, TCT range

7.3 *Assessment*

Noise contour maps were calculated on the basis of the above-mentioned measurements and assumptions; they can be found in Annex C1 and C2 . The calculation height was 6 m above the ground and the calculation points were on a 50 m x 50 m grid.

In the direct vicinity of the range, the large screening effect of the high wall behind the range and the wall on the eastern side is easily recognizable by the "dents" in the contours. Also easily recognizable is the decrease in the screening influence with increasing distance from the range. However, at greater distances only the directional response of the weapons is recognizable: the distance of an iso-dB line to the range is greatest at ±60° and smallest at 180°.

7.3.1 Day

The noise contour map shows that during the day all residential areas requiring protection lie outside of the 55 dB(A) contour. Here, then, the imission guide value for general residential areas is adhered to.

7.3.2 Night

The situation is far more critical at night. This is because the 2,400 rounds fired during the assessment period of the most unfavorable night hour (here: 2200 - 2300) represent approximately as many rounds as are fired during the one hour daytime mean (40,000 rounds per day correspond to 2,500 rounds per hour). On the other hand, the imission guide values are 15 dB lower at night than during the day. The noise contour map indicates three critical areas, which will now be described more closely.

A level of up to 54 dB(A) is reached at the "An der Wildbahn" farm buildings at night. The imission guide value is thus exceeded by up to 9 dB(A). An assessment as mixed zone appears appropriate, as the farm is located in an undeveloped outskirt area. The levels given here may be between 3 and 10 dB lower on the sides of the buildings away from the source.

The 40 dB(A) isophonic line runs through the middle of Hüttenfeld. In principle, therefore, around 25 % of buildings may experience violations of the imission guide value for general residential areas. The transgression may be up to 3 dB(A). These values will certainly not be reached on a great number of buildings in the town because other buildings screen them. However, these values may be reached on non-screened or freestanding buildings at the edge of town towards the range. The imission guide value for mixed zones, on the other hand, can be adhered to for the whole of Hüttenfeld. It does seem doubtful, however, whether the area in question can actually be classified as a mixed zone.

Neuschloß lies almost completely within the 40 dB(A) isophonic line. In principle, therefore, buildings may experience transgressions of the imission guide value for general residential areas. The violation is 7 dB(A) at the eastern edge of town. These values will certainly not be reached on a great number of buildings in the town because other buildings screen them. However, these values may be reached on non-screened or freestanding buildings at the edge of town towards the range. Parts of the eastern area of the town actually lie directly within the 45 dB(A) isophonic line and thus demonstrate violations of the imission guide value for mixed zones of up to 2 dB(A). Nonetheless, in around 80 % of the town area the imission guide value for mixed zones is adhered to. It does seem doubtful, however, whether the area in question can actually be classified as a mixed zone.

7.4 *Noise abatement measures*

In order to improve the noise situation for those concerned the following noise abatement measures may be considered in principle:

- additional screening at the range (baffles),
- reduction of rounds fired after 2200.

The noise conflict will very likely not be solved by a simple reduction in rounds fired. In order to adhere to the imission guide values at "An der Wildbahn" farm, a total of approximately 300 rounds only would be permissible in the most unfavorable nighttime hour. With reference to Neuschloß and Hüttenfeld only, this value would be around 500 (general residential area) or 1,500 (mixed zone).

8 Spinelli Barracks

Spinelli Barracks is situated between Mannheim-Käfertal and Mannheim-Freudenheim and is bounded to the Southwest by the roads Am Aubuckel and Wingertsbuckel, to the East by agricultural land and to the North by Wachenheimer Strasse and Anna-Sammet-Strasse and a sports field. However, relevant sources are only found to the South of Spinelli Barracks near two buildings (1570 and 1572). Military vehicles are serviced and tested hardly – partly in the open.

Residential areas requiring protection can be found in the East and South, either directly bordering or separated only by a road. The area around the investigated buildings consists of a mixed zone with commercial uses and individual residential buildings on Talstrasse.

Noise measurements were taken on 07/16/2003 near buildings 1570 and 1572. The results are described here. The locations of the measurement points and sources can be seen in Figure 4.

Figure 4: Measurement points and sources in Spinelli Barracks

8.1 *Building 1570*

Two measurements were taken close to Building 1570. The measurements were taken approximately 9 m East of Building 1570 at a height of 6 m.

The first measurement recorded the noises generated in connection with work on the brake-testing rig. The brake-testing rig is located at the eastern end of Building 1570 on the South side. The distance to the measurement point was around 12 m. The noises recorded encompass the following activities:

- work directly at the brake-testing rig (2 trucks, 1 all-terrain vehicle)

- maneuvering to the rig (2 trucks, 1 all-terrain vehicle)
- long parking periods at idle (truck)
- starting aid (truck-truck, multiple)
- passing by and parking of vehicles close to Building 1570 and driving into the servicing sheds (several trucks and all-terrain vehicles)

The measured time-averaged sound pressure level L_{eq} was 62 dB(A).

During the second measurements those noises were recorded which are connected with other work activities on the working area in front of Building 1570 as well as those arising from work inside Building 1570 with the shed doors open. The distance from the measurement point to the center of the working area was around 50 m. The noises recorded encompass the following activities:

- arrival and departure of vehicles (several trucks and all-terrain vehicles)
- long parking periods at idle (truck)

The measured time-averaged sound pressure level L_{eq} was 57 dB(A).

Using the measured values and with the help of the model, the sound power level L_{WA} of the sources was back-projected.

The appropriate time corrections were also taken into consideration. Because only one of the two sources was active at any one time during measurements and both time periods were of equal duration, a time correction of -3 dB is adopted for both sources. According to an employee the working hours are from 0900 to 1130 and from 1300 to 1630, i.e. a total of 6 hours during 16 hours of the daytime period. This gives a time correction of -4 dB.

In summary, the following sound power levels result for a 16-hour assessment period during the daytime:

- brake-testing rig: L_{WA} = 102 dB(A)
- working area, Building 1570: L_{WA} = 93 dB(A)

8.2 *Building 1572*

One measurement was carried out close to Building 1572. The measurements were taken approximately 20 m East of Building 1570 at a height of 6 m.

During the measurements those noises were recorded which are connected with work activities on the working area in front of Building 1572, as well as those arising from work inside Buildings 1572 and 1577 with the shed doors open. The distance from the measurement point to the center of the working area was around 65 m. The noises recorded encompass the following activities:

- maneuvering of vehicles (several trucks and all-terrain vehicles),

- long parking periods at idle (truck),
- use of compressed air tools inside the shed,
- outdoor use of high pressure cleaners,
- forklift operations.

The measured time-averaged sound pressure level L_{eq} was 62 dB(A).

Using the measured value and with the help of the model, the sound power level L_{WA} of the source was back-projected.

The appropriate time corrections were also taken into consideration. According to an employee the working hours are from 0730 to 1200 and from 1230 to 1600, i.e. a total of 8 hours during 16 of the daytime period. This gives a time correction of -3 dB.

The following sound power level results for a 16-hour assessment period during the daytime:

- working area, Building 1572: L_{WA} = 101 dB(A)

8.3 *Assessment*

A noise contour map was calculated on the basis of the above-mentioned measurements and assumptions; it can be found in Annex D . The calculation height was 6 m above the ground and the calculation points were on a 10 m x 10 m grid. Because no work is carried out at night, a night map and assessment can be dispensed with.

The noise contour map shows that values up to 61 dB(A) were reached along the property boundary. No assessment is deemed necessary as the buildings at the property boundary are only storage sheds, workshops and similar usage. Residential buildings do not occur until East of Talstrasse. The maximum levels here are 53 dB(A). The Talstrasse area can be classified as a mixed zone or even a commercial zone due to the uses occurring here. The levels are therefore 7 and 12 dB(A) respectively lower than the permissible imission guide value. There are no noteworthy noise effects on further areas requiring protection within either Spinelli Barracks or the neighboring residential areas.

At the current time no noise abatement measures are deemed necessary.

9 ANNEXES

Noise Rating Level Contour Maps

A1 BFV daytime
A2 BFV night
B1 Coleman Barracks daytime
B2 Coleman Barracks night
C1 Lampertheim LTA daytime
C2 Lampertheim LTA night
D Spinelli Barracks daytime

E POC list

Noise Rating Level Contour Maps

POC list

POC	Function	Phone numbers	e-mail
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Boone, Terry	293rd BSB DPW	DSN 381-8675 0621-730-8675 Fax 0621-730-8289	
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Mr. Cruz	Lampertheim LTA	DSN 382-5504 0621-779-5504	cruzl@ cmtymail.26asg.army.mil
Mr. Turshon	Lampertheim LTA	DSN 382-5107 0621-779-5107	
Mr. Bucher	BFV (PX)	0621-735066	
Ms. Hudson	BFV (Food mall)	0621-723119	
LTC Davis	Spinelli Bks (Motor pools)	DSN 384-6378 0621-730-6378	Jimmy.davis@ 51maint.21tsc.army.mil
SFC Giove	Spinelli Bks (Motor pools)	DSN 384-6135 0621-730-6135	Mitch.giove@ 51maint.21tsc.army.mil
MSG Taylor	Turley Bks (Motor pools)	DSN 380-9642 0621-730-9642	